

# A key to the species of *Hyphodontia* sensu lato

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## Abstract

A dichotomous key to all currently accepted species of *Hyphodontia* in the broad sense is presented. It consists of a key to genera (*Alutaceodontia*, *Botryodontia*, *Chaetoporellus*, *Deviodontia*, *Hastodontia*, *Hyphodontia* s. str., *Kneiffiella*, *Lagarobasidium*, *Lyomyces*, *Palifer*, *Rogersella*, *Schizopora*, *Xylodon*) and detailed keys to species level within genera. The key also includes taxa which were published under preliminary names (such as ‘*Hyphodontia* species A’) and some taxa which require taxonomic clarification (like *Hyphodontia macrescens*). Some recently describes *Hyphodontia* species are placed in the keys to *Palifer* and *Xylodon* due to their morphology.

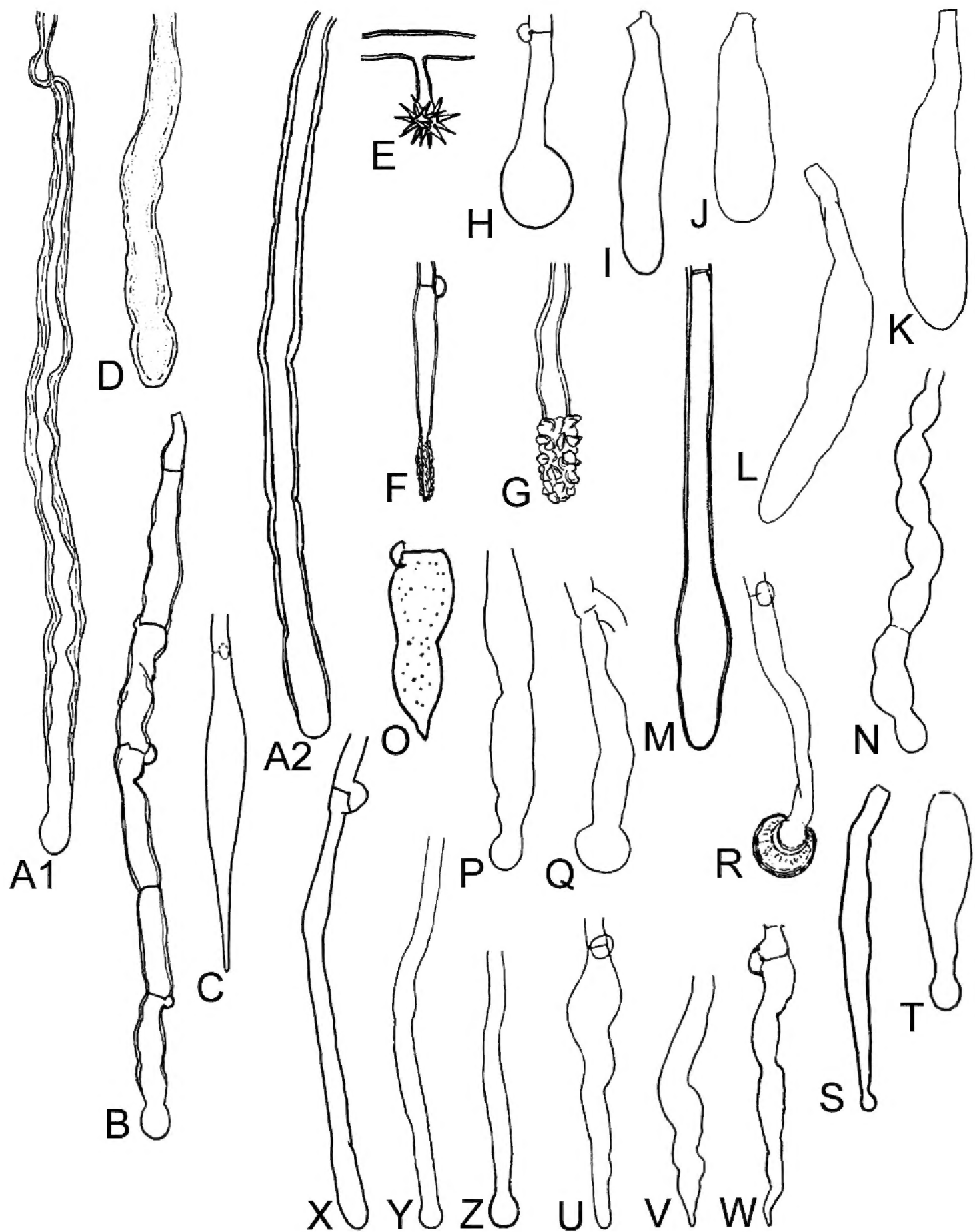
## Key words

Basidiomycota, cystidia, global species diversity, Hymenochaetales, taxonomy

## Introduction

*Hyphodontia* J. Erikss. (Hymenochaetales) in its broad sense is a genus of resupinate non-poroid Basidiomycota. Its species commonly occur on dead wood worldwide from Arctic tundra (Mukhin 2006) to evergreen equatorial forests (Hjortstam et al. 1998). In the latter case they belong in the strict sense mainly to *Botryodontia* and *Schizopora*. The latest global monograph of the genus (Langer 1994) included descriptions of 53 *Hyphodontia* species and 4 *Schizopora* species.

The aim of our work was to construct a key, which can serve as a tool for further studies of *Hyphodontia* s. l., especially when describing new species. The key includes 126 validly published species, four unnamed taxa (e.g. *Hyphodontia* sp. 1), and three



**Figure 1.** Types and shapes of cystidial elements in *Hyphodontia* s.l.: **A1** skeletocystidium **A2** tubular **B** septocystidium **C** hastocystidium **D** gloeocystidium **E** astrocystidium **F** lagenocystidium **G** cylindrical apically encrusted (lamprocystidium-like) **H** vesicular or bladder-like (embedded) **I** cylindrical **J** sub-clavate **K** clavate **L** fusoid **M** spatuliform **N** moniliform (torulose) **O** ventricose submucronate **P** subcapitate **Q** capitate **R** capitate with resinous cap **S** capitulate **T** lecythiform **U** tapering (subulate with blunt apex) **V** acute **W** acuminate (subulate with pointed apex) **X** hyphoid cylindrical **Y** hyphoid subcapitate; **Z**, hyphoid capitate. See also Appendix.

taxa with affinity formulation (e.g. *Kneiffiella* cf. *abieticola*), for which brief or detailed descriptions have been published. The taxa requiring taxonomic clarification, e.g. species with poor types (*Kneiffiella byssoidea*, *Xylodon nudisetus*, *X. rimosissimus*; Parmasto et al. 2004), are included in the key equally with ‘good’ taxa.

For identification convenience, the species are assigned to 13 derivative genera, adopted by Hjortstam and Ryvarden (2009). However, among these genera the independence of *Hastodontia*, *Hyphodontia* s. str., *Kneiffiella*, and *Lagarobasidium* only is confirmed by molecular phylogenies (Larsson et al. 2006; Yurchenko and Wu 2014). Species of *Fibrodontia* were excluded because they belong to trechisporoid lineage (Larsson 2007). *Palifer seychellensis* Dämmrich & Rödel was excluded from consideration because of unusual cystidia with double umbrella-like incrustations and probable belonging to the genus *Sceptrulum* K.H. Larss. (Karasiński 2014). In addition to the concept of *Hyphodontia* s. l., the genus *Botryodontia* in the key as several species in this genus have been earlier combined in *Hyphodontia* s. l. as well. *Botryodontia* is related to *Oxyporus* (Sell et al. 2014), and is a presumed member of the hymenochaetoid clade.

Because of the diffuse generic borders within *Hyphodontia* s. l., the species are listed in the key with their main synonyms when combined in different genera. Recently described *Hyphodontia* species, that have never been combined in other genera, are included in the appropriate subordinate keys according to their morphology. For example, *H. septocystidiata* is keyed within *Palifer* and *H. heterocystidiata* within *Xylodon*. Morphological types of cystidia, important for the identification of genera and species, are illustrated on Fig. 1. Spore quotient (length/width ratio) is denoted in the key as Q. Distribution of each species in parts of the world is given after “distr.”

## Keys

### Key to the segregated genera and some species within *Hyphodontia* s. l.

- 1 Spores warted or minutely echinulate, globose, slightly thick-walled.....  
.....***Rogersella*** [*R. griseliniae* (G. Cunn.) Stalpers (*Hyphodontia griseliniae* (G. Cunn.) E. Langer ‘griselinae’, *R. asperula* Liberta & A.J. Navas)]; distr.: Macaronesia, Africa, southwest Indian Ocean islands, South America, New Zealand, Oceania  
The other known species in the genus, *R. eburnea* Hjortstam & Högholen, should according to its morphology (subceraceous basidioma, smooth hymenophore, gelatinized subhymenial hyphae, subclavate basidia, suballantoid spores) be classified as *Phlebia* s. l.
- Spores smooth, globose to cylindrical or allantoid, thin- to thick-walled.....**2**
- 2 Clamps lacking at all septa.....**3**
- Clamps present at some, at many, or at all primary septa.....**6**
- 3 Basidia obovate to clavate .....**4**
- Basidia cylindrical-utriform .....**5**

- 4 Hymenophore granulose to irpicoid-labyrinthoid; capitate cystidia absent....  
.....*Botryodontia*...(Key A)
- Hymenophore poroid; small capitate cystidia numerous.....  
.....*Xylodon poroideoefibulatus*
- 5 Basidia with 4 sterigmata .....*Botryodontia tetraspora*
- Basidia with 2 sterigmata .....*Kneiffiella efibulata*
- 6 Lagenocystidia or lagenocystidia-like elements (like small lamprocystidia)  
present in hymenium.....7
- Lageno- and similar encrusted cystidia lacking.....8
- 7 With rare to numerous lagenocystidia, or with apically richly encrusted, short  
cylindrical cystidia .....*Hyphodontia* s. str...(Key D)
- With lamprocystidia-like elements..... *Palifer*...(Key H)
- 8 Hymenophore distinctly irpicoid or poroid .....9
- Hymenophore smooth to odontoid and hydroid, seldom slightly irpicoid or  
with spathulate aculei .....12
- 9 Hyphal system monomitic.....10
- Hyphal system dimitic, trimitic or pseudodimitic (subdimitic) with skeletal-  
like hyphae in subiculum .....11
- 10 Spores allantoid, about 0.8  $\mu\text{m}$  broad .... *Chaetoporellus* (*Ch. latitans*)...(Key B)
- Spores subglobose to cylindrical or suballantoid, at least 2  $\mu\text{m}$  broad.....  
.....*Xylodon*...(Key J)
- 11 In hymenium moniliform cystidia ..... *Xylodon bresinskyi*
- Constricted cystidia absent ..... *Schizopora*...(Key I)
- 12 Spores allantoid, 0.5–1.5(–2)  $\mu\text{m}$  broad.....13
- Spores subglobose to cylindrical or suballantoid, broader, than 2  $\mu\text{m}$  .....16
- 13 Tubular thick-walled cystidia present.....*Kneiffiella*...(Key E)
- Tubular thick-walled cystidia absent, but cylindrical thin-walled cystidia  
sometimes present.....14
- 14 Hymenophore with aculei reaching 1–2 mm long; spores significantly curved,  
4–5  $\mu\text{m}$  long..... *Chaetoporellus* (*Ch. curvisporus*)...(Key B)
- Hymenophore with aculei less than 1 mm long; spores slightly or moderately  
curved, 5–8  $\mu\text{m}$  long.....15
- 15 Spores 6–8  $\times$  1.5(–2)  $\mu\text{m}$ ; cystidia cylindrical to torulose, mostly 50–75  
 $\times$  4–7  $\mu\text{m}$ ; some samples with conidia 8–10  $\times$  3–4  $\mu\text{m}$  in hymenium...  
.....*Alutaceodontia* (Parmasto)  
Hjortstam & Ryvarde[n] [A. *alutacea* (Fr. : Fr.) Hjortstam & Ryvarde[n] (*Hypho-*  
*dontia alutacea* (Fr. : Fr.) J. Erikss.); distr.: Eurasia, North and South America
- Spores 5–6  $\times$  1–1.5  $\mu\text{m}$ ; only with subclavate cystidioles or basidioles, 8–10  
 $\times$  3–3.5  $\mu\text{m}$ , and projecting cylindrical and subcapitate hyphal ends; conidia  
unknown ..... *Xylodon scopinellus*
- 16 Hyphal system dimitic with skeletal hyphae, or subdimitic because of the prese-  
nce of thick-walled hypha-like bases of tubular cystidia, or pseudodimitic due  
to skeletoid (skeletal-like) hyphae in aculeal trama or dissepiment ..... 17

- Hyphal system monomitic, but subicular hyphae and hyphae in aculeal trama can be thick-walled ..... **19**
- 17 With tubular cystidia ..... ***Kneiffiella*... (Key E)**
- Typical tubular cystidia lacking, but elements of intermediate morphology between hyphae and tubular cystidia present in aculeal trama ..... **18**
- 18 Aculeal trama with skeletocystidia: long, narrow, thick-walled, often yellow-pigmented in mass, naked or covered with tablet-shaped crystals; capitate or subcapitate hyphal ends or cystidia absent in aculei; basidia when mature suburniform ..... ***Fibrodontia***
- Aculeal trama with skeletal-like hyphae or with thick-walled hyphoid cystidia, often encrusted (crystals not flattened); capitate or subcapitate cystidial elements present in aculei; basidia more or less utriform ... ***Xylodon*... (Key J)**
- 19 Spores cyanophilous with distinctly thickened or thick wall ..... **20**
- Spores acyanophilous (rarely somewhat cyanophilous) thin- or slightly thick-walled ..... **21**
- 20 Capitate cystidia often with a resinous cap; cylindrical cystidia embedded ....  
..... ***Xylodon crassisporus***
- Capitate cystidia if present, lack the resinous cap; cylindrical cystidia if present, distinctly projecting ..... ***Lagarobasidium*... (Key F)**
- 21 Hymenophore coarsely odontoid, raduloid or semiporoid, with aculei 1–5(–7) mm long; cystidia clearly capitate, with broadened base, projecting clearly over the basidia, 50–85 × 7–10 µm; basidia nearly subcylindrical .....  
..... ***Deviodontia* (Parmasto) Hjortstam & Ryvarden [*D. pilicystidiata* (S. Lundell) Hjortstam & Ryvarden (*Hyphodontia pilicystidiata* (S. Lundell) J. Erikss. '*pilaecystidiata*')]; distr.: Europe Langer (1994) proposed to treat this taxon in *Hyphoderma* because of large capitate cystidia and spores with granular contents.**
- Hymenophore smooth to hydroid, raduloid or poroid; aculei rarely up to 3 mm long; projecting capitate cystidia, if present, often smaller, and frequently classified as capitate hyphal ends or cystidioles; basidia usually utriform
- 22 Septocystidia present, distinct ..... ***Hyphodontia* s. str... (Key D)**
- Septocystidia absent or little differentiated ..... **23**
- 23 Hymenophore smooth to slightly tuberculate; generally two types of cystidia: (1) moniliform, embedded or slightly projecting, (2) projecting, capitate cystidia or hastocystidia, apically often with resinous excretion; spores subcylindrical ..... ***Hastodontia*... (Key C)**
- If with moniliform cystidia, then hymenophore odontoid or hydroid, or spores ellipsoid; projecting capitate cystidia naked or with resinous cap; hastocystidia if present, lacking apical excretion; spores globose to subballantoid ..... **24**
- 24 Hymenophore usually odontoid, sometimes almost smooth to hydroid or poroid; usually with tufts of projecting hyphal ends or cystidia in hymenophoral aculei; hymenial surface usually cream-colored; spores thin-walled, rarely somewhat thick-walled, subglobose to subballantoid, acyanophilous,



- rarely somewhat cyanophilous; cystidia subulate to cylindrical, capitate or moniliform; subicular hyphae naked to richly encrusted ... ***Xylodon*...** (Key J)
- Hymenophore smooth to tuberculate; typically no tufts of projecting hyphal ends or cystidia; hymenial surface white or with age pale cream, in herbarium material white, cream or yellowish; spores thin- to somewhat thick-walled, globose to oblong, slightly or distinctly cyanophilous; cystidia capitate or fusoid, or of both types; subicular hyphae usually encrusted ..... ***Lyomyces*...** (Key G)

### Key A. *Botryodontia*

- 1 Cystidia long (40–180  $\mu\text{m}$ ), cylindrical, tubular, more or less thick-walled ... 2
- Cystidia never tubular, thin-walled, sometimes indistinct, 15–40  $\mu\text{m}$  long.... 4
- 2 Spores 3–5  $\times$  2–2.5  $\mu\text{m}$ ; hymenophore minutely warted.....
- B. tetraspora*** (S.S. Rattan) Hjortstam & Ryvar den [*Hyphodontia efibulata* f. *tetraspora* S.S. Rattan; *H. tetraspora* (S.S. Rattan) Hjortstam; *Kneiffiella tetraspora* (S.S. Rattan) Hjortstam & Ryvar den]; distr.: South Asia
- Spores 4–6.5  $\times$  3–4  $\mu\text{m}$ ; basidioma farinaceous-granulose or hymenophore odontoid to irpicoid..... 3
- 3 Basidioma farinaceous-granulose; spores with thin or thickened walls, 5–6(–6.5)  $\times$  3–4  $\mu\text{m}$  ..... ***B. crassispora*** P. Roberts [*Kneiffiella crassispora* (P. Roberts) Hjortstam & Ryvar den]; distr.: Africa
- Basidioma odontoid or raduloid-irpicoid; spores thin-walled, 4–5  $\times$  3–3.7  $\mu\text{m}$ ..... ***B. subglobosa*** (Sheng H. Wu) Hjortstam [*Hyphodontia subglobosa* Sheng H. Wu; *Kneiffiella subglobosa* (Sheng H. Wu) Hjortstam]; distr.: East Asia
- 4 Hymenophore irpicoid-labyrinthoid; gloecystidia present in hymenium, clavate or irregular-shaped (sinuous); spores broadly ellipsoid to subglobose, 4–7  $\times$  3.3–5.5  $\mu\text{m}$ ..... ***B. millavensis*** (Bourdot & Galzin) Duhem & H. Michel; distr.: Europe
- Hymenophore semi-odontoid to odontoid; gloecystidia absent; spores ellipsoid, 5–6.5  $\times$  3.5–4.5  $\mu\text{m}$  ..... 5
- 5 Hymenophoral aculei 0.1–0.3 mm long; spores (5–)5.5–6(–6.5)  $\times$  4–5  $\mu\text{m}$ ..... ***B. cirrata*** (Hjortstam & Ryvar den) Hjortstam [*B. denticulata* Hjortstam; *B. formosana* (Sheng H. Wu & Burds.) Hjortstam; *Hyphodontia formosana* Sheng H. Wu & Burds.]; distr.: pantropical
- Hymenophoral aculei 0.4–0.5(–0.75) mm long; spores 5–5.5(–6)  $\times$  (3.5–)3.8–4(–4.3)  $\mu\text{m}$ .....
- ..... ***B. semispathulata*** Hjortstam & Ryvar den; distr.: South America

### Key B. *Chaetoporellus* Bondartsev & Singer

- 1 Hymenophore odontoid or sometimes almost smooth; cystidia 35–70  $\times$  4–7  $\mu\text{m}$ ; spores 4–5  $\times$  1–1.5(–2)  $\mu\text{m}$  .....

- ..... ***Ch. curvisporus*** (J. Erikss. & Hjortstam) J. Erikss. & Hjortstam (*Hyphodontia curvispora* J. Erikss. & Hjortstam); distr.: Europe, Central America
- Hymenophore poroid with rounded, lacerate or labyrinthiform pores; cystidia  $30\text{--}35 \times 4\text{--}5 \mu\text{m}$ ; spores  $3\text{--}4 \times 0.5\text{--}1 \mu\text{m}$  ..... ***Ch. latitans*** (Bourdot & Galzin) Bondartsev & Singer [*Hyphodontia latitans* (Bourdot & Galzin) Ginns & Lefebvre]; distr.: Europe, North America, Oceania

### Key C. *Hastodontia* (Parmasto) Hjortstam & Ryvarden

- 1 With capitate projecting cystidia,  $30\text{--}60 \times 4\text{--}5 \mu\text{m}$ , capped by resinous matter (the matter usually disappearing in microscopic slides); acute cystidia absent; spores  $4.5\text{--}5.5 \times 2\text{--}2.5 \mu\text{m}$  ..... ***H. halonata*** (J. Erikss. & Hjortstam) Hjortstam & Ryvarden (*Hyphodontia halonata* J. Erikss. & Hjortstam); distr.: Europe
- No capitate cystidia; with projecting hastocystidia, about  $50 \mu\text{m}$  long,  $5\text{--}7 \mu\text{m}$  wide, some of them apically with a globe of resinous matter (the matter easily dissolving in slides); spores  $5\text{--}7 \times 2\text{--}3 \mu\text{m}$  ..... ***H. hastata*** (Litsch.) Hjortstam & Ryvarden [*Hyphodontia hastata* (Litsch.) J. Erikss.]; distr.: temperate north hemisphere

### Key D. *Hyphodontia* J. Erikss. s. str.

- 1 Hymenophore poroid ..... ***H. borbonica*** Riebesehl, E. Langer & Barniske; distr.: southwest Indian Ocean islands
- Hymenophore smooth to hydroid ..... **2**
- 2 Capitate or subcapitate cystidial elements lacking ..... ***H. wrightii*** Hjortstam & Ryvarden [*Palifer wrightii* (Hjortstam & Ryvarden) Hjortstam & Ryvarden]; distr.: South America  
The species was included in *Hyphodontia* s. str. by Gorjon (2012).
- Capitate or subcapitate cystidial elements present ..... **3**
- 3 With capitate or subcapitate septocystidia (usually with 2–3 septa), distinctly protruding above the hymenium; hymenophore smooth to grandinioid ..... **4**
- Capitate or subcapitate cystidia usually with a basal septum only, little protruding above the hymenium, or hypha-like and arranged in tufts at aculeal apices; hymenophore smooth to hydroid ..... **8**
- 4 Lagenocystidia more or less numerous ..... **5**
- Lagenocystidia absent or occasional ..... **6**
- 5 Spores  $4.5\text{--}5 \times 3\text{--}3.5 \mu\text{m}$ ; septocystidia up to  $80 \mu\text{m}$  long ..... ***H. alutaria*** (Burt) J. Erikss.; distr.: cosmopolitan
- Spores  $6\text{--}7.5 \times 4\text{--}4.5 \mu\text{m}$ ; septocystidia up to  $110 \mu\text{m}$  long ..... ***H. subdetritica*** S.S. Rattan (*H. propinqua* Hjortstam); distr.: Asia, Africa
- 6 Spores  $3.5\text{--}5 \times 2\text{--}3 \mu\text{m}$ ; septocystidia  $80\text{--}120 \mu\text{m}$  long, slightly thick-walled ..... **7**

- Spores  $5\text{--}8 \times 4\text{--}5.5 \mu\text{m}$ ; septocystidia  $60\text{--}73 \times 6\text{--}7 \mu\text{m}$ , thin-walled .....  
     ....***H. subpallidula*** H.X. Xiong, Y.C. Dai & Sheng H. Wu; distr.: East Asia
- 7. Hymenophore smooth or finely tuberculate; subicular hyphae thin-walled,  $2\text{--}3 \mu\text{m}$  wide, moderately densely packaged; septocystidia  $4\text{--}6 \mu\text{m}$  wide; spores  $3.5\text{--}5.5 \times 2\text{--}3 \mu\text{m}$  .....***H. pallidula*** (Bres.) J. Erikss.; distr.: Eurasia, North America
- Hymenophore odontoid; subicular hyphae with thickened walls,  $4\text{--}5 \mu\text{m}$  wide, loosely arranged; septocystidia  $7\text{--}8 \mu\text{m}$  wide; spores  $4.5\text{--}5 \times 3 \mu\text{m}$  .....  
     .....***H. alba*** Sheng H. Wu; distr.: East Asia
- According to Hjortstam and Ryvarden (2009), this species has features of *Hyphoderma* and *Lyomyces*.
- 8 Hymenial surface smooth; no capitate cystidia; lagenocystidia few, sometimes absent ..... ***H. subdetritica*** (see step 5)
- Hymenial surface odontoid to hydroid; capitate cystidia present; lagenocystidia scattered to numerous ..... **9**
- 9 Spores up to  $4.5 \mu\text{m}$  long, globose to broadly ellipsoid, slightly thick-walled ..... ***H. sphaerospora*** (N. Maek.) Hjortstam [*H. arguta* var. *sphaerospora* (N. Maek.) N. Maek.]; distr.: East and Southeast Asia, South America
- Spores up to  $5\text{--}6 \mu\text{m}$  long, ellipsoid to cylindrical, occasionally subglobose, thin- to slightly thick-walled ..... **10**
- 10 Spores ellipsoid, occasionally subglobose,  $(4\text{--})4.5\text{--}6 \times (3\text{--})3.5\text{--}3.7(\text{--}4) \mu\text{m}$  ...  
     .....***H. arguta*** (Fr. : Fr.) J. Erikss. [*H. lageniformis* Sang H. Lin & Z.C. Chen, *H. stipata* (Fr. : Fr.) Gilb.]; distr.: cosmopolitan  
*H. lageniformis* is synonymized with *H. arguta* (Langer 1994), and evidently is a variety of the latter, with smaller spores ( $4.5 \times 3\text{--}4 \mu\text{m}$ ) and shorter basidia ( $10\text{--}11 \mu\text{m}$ , according to the original description).
- Spores narrowly ellipsoid to cylindrical,  $4.3\text{--}5.3 \times 2\text{--}3 \mu\text{m}$  ..... **11**
- 11 Hymenophoral aculei up to 3 mm long; spores  $4.5\text{--}5 \times 2\text{--}2.5(\text{--}3) \mu\text{m}$ ; mucronate (apically papillate) cystidia present; lagenocystidia scattered; capitate cystidia in aculeal apices; basidia  $10\text{--}15 \mu\text{m}$  long .....  
     .....***H. ochroflava*** (Pat.) Nakasone; distr.: Southeast Asia
- Hymenophoral aculei up to 6 mm long; spores  $4.3\text{--}5.3 \times 2.5\text{--}3 \mu\text{m}$ ; no mucronate cystidia; capitate cystidia also on lateral surfaces of aculei; lagenocystidia numerous; basidia  $22\text{--}28 \mu\text{m}$  long .....  
     .....***H. dhingrae*** Samita & Sanyal; distr.: South Asia

#### Key E. *Kneiffiella* P. Karst.

- 1 Clamps absent at all septa ..... **2**
- Clamps present at all or most primary septa ..... **3**
- 2 Spores subglobose to ellipsoid,  $4\text{--}4.5(\text{--}5) \times (2.5\text{--})3(\text{--}3.5) \mu\text{m}$  .....  
     .....***K. byssoidea*** (H. Furuk.) Hjortstam & Ryvarden ‘*byssoideus*’  
     [*Hyphodontia byssoidea* (H. Furuk.) N. Maek. ‘*byssoideum*’]; distr.: East Asia



- Spores oblong to cylindrical, adaxially flat or concave,  $5\text{--}5.5 \times 2\text{--}2.5 \mu\text{m}$ .....  
.....***K. efibulata*** (J. Erikss. & Hjortstam) Jülich & Stalpers (*Hyphodontia efibulata* J. Erikss. & Hjortstam); distr.: Europe
- 3 Spores broadly ellipsoid to short cylindrical,  $Q = 1.4\text{--}2.2$  ..... 4
- Spores cylindrical to allantoid,  $Q = (1.9\text{--})2.3\text{--}4$  ..... 11
- 4 Spores broadly ellipsoid to ellipsoid,  $Q = 1.4\text{--}1.7$ ; hymenophore odontoid to hydroid ..... 5
- Spores narrowly ellipsoid to short cylindrical,  $Q = (1.6\text{--})1.8\text{--}2.2$ ; hymenophore smooth to odontoid ..... 7
- 5 Subicular hyphae with clamps at all primary septa; spores  $4.5\text{--}6 \times 3\text{--}4.5 \mu\text{m}$  ... 6
- Subicular hyphae partly simple septate; sometimes clamps only scattered on subicular hyphae and on projecting hyphae in the aculei; spores  $3.5\text{--}5 \times 2.5\text{--}3.5 \mu\text{m}$ .....***Hyphodontia orasinusensis*** Gilb. & M. Blackw. [*Kneiffiella crassa* (Rick) Hjortstam & Ryvarde, non *Hyphodontia crassa* Z.C. Chen & Sang H. Lin; *K. stereicola* (Bres.) Nakasone]; distr.: North America
- 6 Hymenophore hydroid with aculei 1–3 mm long; tubular cystidia 6–8  $\mu\text{m}$  broad; spores often broadly ellipsoid,  $4.5\text{--}5.5(6) \times 3.5\text{--}4.5 \mu\text{m}$  ....***K. barba-jovis*** (Bull. : Fr.) P. Karst. [*Hyphodontia barba-jovis* (Bull. : Fr.) J. Erikss., *H. irpicoides* (P. Karst.) Burds. & M.J. Larsen]; distr.: Eurasia, North America
- Hymenophore odontoid or minutely hydroid, with aculei less 1 mm long; tubular cystidia 4–6  $\mu\text{m}$  broad; spores ellipsoid,  $5\text{--}6 \times 3\text{--}3.5 \mu\text{m}$  .....  
.....***K. cf. abieticola*** (Hjortstam and Ryvarde 2007b); distr.: South America
- 7 Some tubular cystidia with excreted resinous matter near or on apex; excretion stable or slowly disappearing in 5% KOH solution ..... 8
- Tubular cystidia without resinous excretion in apical part ..... 9
- 8 Hymenial surface smooth to odontoid, cream to beige; spores  $2.5\text{--}4.5 \times 1.5\text{--}2.5 \mu\text{m}$ , ellipsoid to cylindrical; tubular cystidia reaching about  $100 \times 8 \mu\text{m}$  in size, with the wall up to 2  $\mu\text{m}$  thick; cystidial apical or subapical excretion crust-like, preserving in KOH; subicular hyphae 2–3  $\mu\text{m}$  broad, with wall up to 1  $\mu\text{m}$  thick ..... ***K. microspora*** (J. Erikss. & Hjortstam) Jülich & Stalpers (*Hyphodontia microspora* J. Erikss. & Hjortstam); distr.: cosmopolitan
- Hymenial surface odontoid, ochraceous; spores  $4\text{--}5.5 \times 2.5\text{--}3 \mu\text{m}$ , cylindrical to somewhat depressed adaxially; tubular cystidia reaching about  $1000 \times 14 \mu\text{m}$  in size, with wall up to 1.5  $\mu\text{m}$  thick; cystidial apical or subapical excretion granular, dissolving in KOH; subicular hyphae 3–4  $\mu\text{m}$  diam, with wall up to 0.5  $\mu\text{m}$  thick .....***K. palmae*** (Rick) Hjortstam & Ryvarde [*Hyphodontia palmae* (Rick) E. Langer]; distr.: South America, East Asia  
This taxon is conspecific with *K. microspora* according to Hjortstam and Larsson (1995).
- 9 Hymenial surface smooth; tubular cystidia usually 80–100  $\mu\text{m}$  long, normally encrusted in the middle part by coarse crystals .....  
.....***K. alienata*** (S. Lundell) Jülich & Stalpers [*Hyphodontia alienata* (S. Lundell) J. Erikss.]; distr.: Europe, Africa, North and South America

- Hymenial surface warted to odontoid; tubular cystidia mostly 100–150  $\mu\text{m}$  long, naked, sometimes scarcely encrusted ..... **10**
- 10 Tubular cystidia cylindrical, with walls up to 2.5  $\mu\text{m}$  thick.....  
.....***K. abieticola*** (Bourdot & Galzin) Jülich & Stalpers [*Hyphodontia abieticola* (Bourdot & Galzin) J. Erikss.]; distr.: Eurasia, North America
- Tubular cystidia thin-walled and tapering in upper half, in lower half with walls up to 1.5  $\mu\text{m}$  thick ***Hyphodontia* sp. A** (Eriksson and Ryvarden 1976; Ginns and Lefebvre 1993); distr.: North America
- 11 Hymenophore smooth (under the lens often porose-reticulate or finely furfureaceous) ..... **12**
- Hymenophore warted, odontoid or distinctly floccose ..... **15**
- 12 Spores 1.5–2  $\mu\text{m}$  broad..... **13**
- Spores 2–3  $\mu\text{m}$  broad..... **14**
- 13 Spores 4.5–6  $\mu\text{m}$  long; tubular cystidia up to 10  $\mu\text{m}$  broad, reaching about 300  $\mu\text{m}$  in length..... ***K. altaica*** (Parmasto) Hjortstam & Ryvarden (*Hyphodontia altaica* Parmasto); distr.: Asia
- Spores 6–8  $\mu\text{m}$  long; tubular cystidia up to 7(–8)  $\mu\text{m}$  broad, reaching about 150(–200)  $\mu\text{m}$  in length ..... ***K. subalutacea*** (P. Karst.) Jülich & Stalpers [*Hyphodontia subalutacea* (P. Karst.) J. Erikss.]; distr.: cosmopolitan
- 14 Tubular cystidia very long (up to 250–280  $\mu\text{m}$ ) and very thick-walled (up to 6  $\mu\text{m}$ ); spores 7–10  $\mu\text{m}$  long.....  
..... ***K. decorticans*** (Gresl. & Rajchenb.) Hjortstam & Ryvarden (*Hyphodontia decorticans* Gresl. & Rajchenb.); distr.: South America
- Tubular cystidia usually not exceeding 120  $\mu\text{m}$  in length, moderately thick-walled; spores 5.5–7  $\mu\text{m}$  long..... ***K. cineracea*** (Bourdot & Galzin) Jülich & Stalpers [*Hyphodontia cineracea* (Bourdot & Galzin) J. Erikss. & Ryvarden]; distr.: Europe, West Asia, South America
- 15 Tubular cystidia very thick-walled (up to 6  $\mu\text{m}$ ); spores 2.5–3  $\mu\text{m}$  broad.....  
..... ***K. decorticans*** (see step 14)
- Tubular cystidia moderately thick-walled (0.5–2.5  $\mu\text{m}$ ); spores 1.5–2.2  $\mu\text{m}$  broad ..... **16**
- 16 Spores cylindrical, slightly concave adaxially, 4.7–5.5  $\mu\text{m}$  long; basidia 7–13  $\mu\text{m}$  long; walls in subicular hyphae thickened to thick (up to 1.2  $\mu\text{m}$ ).....  
..... ***K. tubuliformis*** Sheng H. Wu [*Hyphodontia tubuliformis* (Sheng H. Wu) Hjortstam & Ryvarden]; distr.: East Asia
- Spores allantoid, 5.5–8  $\mu\text{m}$  long; basidia 12–20  $\mu\text{m}$  long; walls in subicular hyphae usually thin or somewhat thickened (less 1  $\mu\text{m}$ )..... **17**
- 17 Hymenophore distinctly floccose to odontoid; tubular cystidia often in clusters at apices of the aculei.....  
..... ***K. floccosa*** (Bourdot & Galzin) Jülich & Stalpers [*Hyphodontia floccosa* (Bourdot & Galzin) J. Erikss.]; distr.: Eurasia, North America  
*Hyphodontia intermedia* (Bourdot & Galzin) Parmasto is considered as a synonym of *K. floccosa* (Hjortstam and Ryvarden 1988). According to the

descriptions in Bourdot and Galzin (1928), there are some differences in spore morphology between the two taxa: spores in *Odontia alutacea* subsp. *intermedia* Bourdot & Galzin are  $6-7.5(-9) \times 1.5-2 \mu\text{m}$ , and in *O. alutacea* subsp. *floccosa* Bourdot & Galzin –  $4.5-7.5 \times 1.5-2.5 \mu\text{m}$ .

- Hymenophore minutely furfuraceous to slightly warted; tubular cystidia not aggregated.....***K. subalutacea*** (see step 13)

#### Key F. *Lagarobasidium* Jülich

- 1 Cylindrical, thick- or very thick-walled cystidia present,  $140-360 \mu\text{m}$  long... **2**
- Cylindrical cystidia, if present, then thin-walled and  $70-110 \mu\text{m}$  long ..... **3**
- 2 Basidioma odontoid, with large,  $140-360 \times 10-12 \mu\text{m}$ , usually aseptate tubular cystidia in aculeal trama; projecting capitate cystidia apically  $12-19 \mu\text{m}$  broad; spores  $5-6 \times 4-5 \mu\text{m}$ , with thickened wall.....  
..... ***L. magnificum*** (Gresl. & Rajchenb.) Hjortstam & Ryvar den (*Hyphodontia magnifica* Gresl. & Rajchenb.); distr.: South America
- Basidioma smooth to grandinioid, with skeletocystidia  $140-160 \times 5-9 \mu\text{m}$ , often with adventitious septa; projecting capitate (spatuliform) cystidia apically  $6-7 \mu\text{m}$  broad; spores  $7-8 \times 5-6 \mu\text{m}$ , thick-walled .....  
... ***L. calongei*** M. Dueñas, Tellería, Melo & M.P. Martín; distr.: Macaronesia
- 3 Cystidia of one type: projecting, clavate to spatuliform in outline; hymenophore first smooth, then papillose to odontoid; hyphae with numerous crystals; spores ellipsoid,  $4-5.5(-6) \times 4-4.5(-5) \mu\text{m}$ .....***L. detriticum*** (Bourdot) Jülich [*Hyphodontia detritica* (Bourdot) J. Erikss., *Hyphodontia magnacystidiata* Lindsey & Gilb., *H. nikolajevae* Parmasto, *Hypochnicium detriticum* (Bourdot) J. Erikss. & Ryvar den, *Lagarobasidium nikolajevae* (Parmasto) Jülich, *L. pruinosum* (Bres.) Jülich]; distr.: Eurasia, South America, southwest Indian Ocean islands *L. pruinosum* is evidently a form of *L. detriticum* with narrowly clavate cystidia that are not spatuliform in outline.
- Cystidia of two types: (1) projecting, capitate with small capitulum, (2) immersed, cylindrical or somewhat moniliform; hymenophore smooth; hyphae naked; spores subglobose to broadly ellipsoid and broadly ovoid,  $(4-)5-6(-6.5) \times 4-5(-5.5) \mu\text{m}$ .....***L. pumilium*** (Gresl. & Rajchenb.) Hjortstam & Ryvar den (*Hyphodontia pumilia* Gresl. & Rajchenb.); distr.: South America

#### Key G. *Lyomyces* P. Karst.

- 1 Spores globose to broadly ellipsoid,  $(5.5-)6-7 \times 5-6.3 \mu\text{m}$ ; cystidia, basidia, and especially basidioles moderately to richly encrusted by fine crystals; cylindrical or subcylindrical cystidia present, up to  $53 \times 7 \mu\text{m}$ ; basidioma often very thin, hypochnoid; subicular hyphae naked .....

- ..... ***L. incrustatus*** (Kotir. & Saaren.) Hjortstam & Ryvarden (*Hyphodontia incrustata* Kotir. & Saaren.); distr.: Europe
- Spores broadly ellipsoid to oblong, 2.5–4.5  $\mu\text{m}$  broad; cystidia and basidioles smooth to moderately encrusted, basidia usually smooth; cylindrical cystidia absent or intermediate in shape to subulate and fusiform; basidioma usually moderately thick; subicular hyphae naked to moderately encrusted ..... **2**
- 2 Capitulate cystidia/cystidioles present, usually numerous ..... **3**
- Capitulate cystidia/cystidioles absent ..... **4**
- 3 Spores narrowly ellipsoid to subcylindrical, (4.5–)5–5.7  $\times$  (2.5–)3–3.5  $\mu\text{m}$ , thin-walled; subicular hyphae thin-walled; subhymenial hyphae usually non-encrusted ..... ***L. erastii*** (Saaren. & Kotir.) Hjortstam & Ryvarden (*Hyphodontia erastii* Saaren. & Kotir.); distr.: temperate Eurasia
- Spores broadly ellipsoid to ellipsoid, sometimes narrowly ellipsoid, 4.5–6(–7)  $\times$  (3–)3.5–4(–4.5)  $\mu\text{m}$ , when mature somewhat thick-walled; subicular hyphae thick-walled; subhymenium rich of crystalline material .....  
..... ***L. sambuci*** (Pers.: Fr.) P. Karst. [*Hyphodontia sambuci* (Pers.: Fr.) J. Erikss., *H. hariotii* (Bres.) Parmasto, *Hyphoderma sambuci* (Pers.: Fr.) Jülich, *Rogersella sambuci* (Pers.: Fr.) Libert & A.J. Navas]; distr.: cosmopolitan
- 4 Basidia with 2(3) sterigmata; spores broadly ellipsoid, 5–6  $\times$  3.5–4.5  $\mu\text{m}$ ; no typical cystidia, only fusiform cystidioles 18–24  $\times$  4(–6)  $\mu\text{m}$ ; hyphae often encrusted, up to 3  $\mu\text{m}$  wide .....  
..... ***L. bisterigmatus*** (Boidin & Gilles) Hjortstam & Ryvarden (*Hyphodontia bisterigmata* Boidin & Gilles); distr.: southwest Indian Ocean islands
- Basidia with 4 sterigmata; spores oblong, 4.5–7.5  $\times$  3–4.5  $\mu\text{m}$ ; with fusiform cystidia 25–35  $\times$  5–7  $\mu\text{m}$ ; hyphae naked, up to 4  $\mu\text{m}$  wide .....  
..... ***L. boninensis*** (S. Ito & S. Imai) Hjortstam & Ryvarden [*Hyphodontia boninensis* (S. Ito & S. Imai) N. Maek. ‘*boninense*’]; distr.: East Asia, Oceania

### Key *H. Palifer* Stalpers & P.K. Buchanan

- 1 Spores thick-walled ..... **2**
- Spores thin-walled ..... **3**
- 2 Projecting, naked, thin-walled septocystidia present in aculei and hymenium between them, 40–80  $\times$  4–5  $\mu\text{m}$ ; spores 3.2–4.3  $\mu\text{m}$  broad .....  
..... ***Hyphodontia septocystidiata*** H.X. Xiong, Y.C. Dai & Sheng H. Wu; distr.: East and Southeast Asia, Central America  
This species is considered to be in the genus *Palifer* due to the presence of numerous short, thick-walled, apically encrusted cystidia.
- True septocystidia absent, but some encrusted cystidia with adventitious septa; spores 3–3.5  $\mu\text{m}$  broad ... ***Hyphodontia rickii*** (Hjortstam & Ryvarden) Gresl. & Rajchenb. [*Lagarobasidium rickii* (Hjortstam & Ryvarden) Hjortstam & Ryvarden, *Hypochnicium rickii* Hjortstam & Ryvarden]; distr.: South America

According to Gorjón (2012), this species should be excluded from *Lagarobasidium* because of encrusted cystidia, similar to those in *P. gamundiae* and *H. erikssonii*.

- 3 Hymenophore smooth or slightly grandinioid; cylindrical cystidia naked, apically obtuse or capitate,  $40\text{--}150 \times 4.5\text{--}7 \mu\text{m}$  .. ***P. verecundus*** (G. Cunn.) Stalpers & P.K. Buchanan [*Hyphodontia verecunda* (G. Cunn.) Hjortstam & Ryvarden]; distr.: South America, New Zealand  
According to Gorjón (2012), *H. verecunda* possesses true lagenocystidia, but in other features fits *Xylodon*.
- Hymenophore grandinioid to odontoid; large cylindrical cystidia absent... 4
- 4 Spores oblong to cylindrical,  $(5\text{--})6\text{--}6.5 \mu\text{m}$  long ..... ***P. gamundiae*** (Gresl. & Rajchenb.) Hjortstam & Ryvarden (*Hyphodontia gamundiae* Gresl. & Rajchenb.); distr.: South America
- Spores broadly ellipsoid to ellipsoid,  $4\text{--}6 \mu\text{m}$  long ..... 5
- 5 Spores  $4\text{--}5 \times 3\text{--}3.5 \mu\text{m}$ ; capitate cystidia apically  $8\text{--}12 \mu\text{m}$  broad, usually naked ..... ***Hyphodontia erikssonii*** (R. Galan & J.E. Wright) Hjortstam & Ryvarden; distr.: South America  
This taxon was included in *Hyphodontia* s. str. by Hjortstam et al. (2005) and Hjortstam and Ryvarden (2009). However, instead of true lagenocystidia, it possesses cylindrical, naked or apically encrusted elements, called in the protologue as “hyphis paraphysoideis”.
- Spores  $5\text{--}6 \times 4\text{--}4.5 \mu\text{m}$ ; capitate cystidia apically  $7\text{--}10 \mu\text{m}$  broad, usually with resinous cap ..... ***P. hjortstamii*** (Gresl. & Rajchenb.) Hjortstam & Ryvarden (*Hyphodontia hjortstamii* Gresl. & Rajchenb.); distr.: South America  
According to Gorjón (2012), this species has encrusted cystidia and spores almost identical to *H. erikssonii*, and can be treated as a probable synonym of the latter.

#### Key I. *Schizopora* Velen.

- 1 Basidioma pileate, broadly dimidiate or with tapering base, sometimes with effused part; hyphal system trimitic with skeletal and binding hyphae; binding hyphae almost lacking a lumen, tortuous, up to  $3.5 \mu\text{m}$  in diam, both in subiculum and trama ..... ***Sch. trametoides*** Núñez; distr.: Southeast Asia
- Basidioma effused or effused-reflexed; hyphal system dimitic or seemingly dimitic, with skeletal or skeletal-like hyphae ..... 2
- 2 In hymenium numerous bottle-shaped cystidia, apically with stellate group of big, rhomboid crystals ..... ***Sch. cystidiata*** David & Rajchenb. [*Hyphodontia cystidiata* (David & Rajchenb.) Hjortstam & K.H. Larss.]; distr.: Africa, southwest Indian Ocean islands  
According to Hjortstam and Ryvarden (2009), this species does not belong to *Schizopora*, but is possibly related to *Porodontia*.



- Cystidia apically without stellate incrustations ..... **3**
- 3 Spores 2.8–4(–4.3)  $\mu\text{m}$  long ..... **4**
- Spores 4–6.5  $\mu\text{m}$  long ..... **5**
- 4 Hyphal system dimitic, skeletal elements abundant in subiculum, 3.5–6  $\mu\text{m}$  diam.; capitate cystidial elements present in hymenium and dissepiment edges, lacking a cap of resinous matter; fusoid cystidia present, about  $20 \times 4 \mu\text{m}$ ; basidia 2-sterigmate; spores  $3\text{--}4 \times 2.3\text{--}3 \mu\text{m}$ , many spores with a conspicuous papilla at one or both ends, reminiscent of conidia formation .....  
..... **Sch. crassihypha** Douanla-Meli; distr.: Africa
- Hyphal system seemingly dimitic, skeletal-like hyphae 2.5–5  $\mu\text{m}$  diam, abundant in central trama; capitate cystidial elements present in subiculum, trama and hymenium, often provided with a cap of resinous matter; fusoid cystidia absent; basidia 4-sterigmate; spores  $3.7\text{--}4.3 \times 2.8\text{--}3.3 \mu\text{m}$ , without papillae ..... **Sch. ovispora** (Corner) Hjortstam & Ryvar den [*Hyphodontia ovispora* (Corner) T. Hatt., *H. tropica* Sheng H. Wu nom. inval.]; distr.: East Asia
- 5 Hyphal system dimitic with skeletal ..... **6**
- Hyphal system subdimitic: some hyphae in trama very thick-walled ..... **8**
- 6 Pores 1–2(–4)/mm; spores (5–)5.5–6(–6.5)  $\times$  (3.3–)3.5–4(–4.5)  $\mu\text{m}$ ; hymenophore irpicoid, denticulate, labyrinthiform, rarely poroid or irregularly-hydroid; capitate cystidia usually few .....  
..... **Sch. paradoxa** (Schr ad. : Fr.) Donk [*Hyphodontia paradoxa* (Schr ad. : Fr.) E. Langer & Vesterh., *Sch. versipora* (Pers.) Teixeira]; distr.: cosmopolitan
- Pores (3)4–6(–8)/mm; spores (3–)4–5  $\times$  3–3.5(–4)  $\mu\text{m}$ ; hymenophore poroid; capitate cystidia common, especially as ‘tramal vesicles’ ..... **7**
- 7 Subulate or fusoid cystidia in hymenium common, apically with crystalline incrustation; capitate cystidia in hymenium inabundant; spores  $4\text{--}5 \times 3\text{--}3.5 \mu\text{m}$  ..... **Sch. flavipora** (Berk. & M.A. Curtis) Ryvar den [*Hyphodontia flavipora* (Berk. & M.A. Curtis) Sheng H. Wu, *H. nongravis* (Lloyd) Sheng H. Wu, *H. subiculoides* (Lloyd) Sheng H. Wu, *Sch. hypolateritia* (Berk. ex Cooke) Parmasto, *Sch. phellinoides* (Pilát) Domański, *Sch. subiculoides* (Lloyd) Ryvar den, *Sch. trichiliae* (Van der Byl) Ryvar den]; distr.: cosmopolitan
- Subulate or fusoid cystidia in hymenium scattered, mostly naked; capitate cystidia in hymenium abundant; spores (3–)3.5–4.8(–5)  $\times$  (2.8–)3–3.5(–4)  $\mu\text{m}$  ....  
..... **Sch. carneolutea** (Rodway & Cleland) Kotl. & Pouzar; distr.: Australia  
This name is synonymized with *Sch. flavipora* by Hjortstam and Ryvar den (2007a).
- 8 Hymenophore poroid with angular or elongate pores, sometimes irpicoid; capitate cystidia usually numerous; spores (4–)4.5–5(–5.5)  $\times$  (2.8–)3–3.5(–3.8)  $\mu\text{m}$  ..... **Sch. radula** (Pers.: Fr.) Hallenb. [*Hyphodontia radula* (Pers.: Fr.) E. Langer & Vesterh.]; distr.: cosmopolitan
- Pores soon torn into narrow teeth, in old specimens teeth aggregated into groups; cystidia absent or not pronounced; spores  $5\text{--}6 \times 2.5\text{--}3 \mu\text{m}$  ..... **Sch. archeri** (Berk.) Nakasone [*Xylodon archeri* (Berk.) Kuntze]; distr.: Australia, New Zealand

Key J. *Xylodon* (Pers.) Gray

- 1 Hymenophore poroid, predominantly poroid or irpicoid/raduloid ..... 2
- Hymenophore smooth to odontoid or hydroid ..... 12
- 2 All hyphae simple-septate *X. poroideoefibulatus* (Sheng H. Wu) Hjortstam & Ryvar den (*Hyphodontia poroideoefibulata* Sheng H. Wu); distr.: East Asia
- Hyphae clamped at all primary septa ..... 3
- 3 Tapering or acuminate cystidia present in hymenium ..... 4
- Hymenial cystidia apically rounded to capitate; tapering cystidial elements absent ..... 8
- 4 Spores cylindrical to subballantoid ..... *X. nothofagi* (G. Cunn.) Hjortstam & Ryvar den [*Hyphodontia nothofagi* (G. Cunn.) E. Langer, *Schizopora nothofagi* (G. Cunn.) P.K. Buchanan & Ryvar den]; distr.: New Zealand
- Spores broadly ellipsoid to ellipsoid ..... 5
- 5 Hyphal system pseudodimitic due to thick-walled (up to 1.5  $\mu\text{m}$ ) hyphae in subiculum and dissepiment; cystidia moniliform, often with a small acuminate apical segment ..... *X. bresinskyi* (E. Langer) Hjortstam & Ryvar den (*Schizopora bresinskyi* E. Langer); distr.: Europe
- Hyphal system monomitic, hyphal walls up to 0.5  $\mu\text{m}$  thick; cystidia not moniliform or only faintly constricted ..... 6
- 6 Spores 4–5.5  $\mu\text{m}$  broad; pores up to 2 mm deep; subiculum up to 0.5 mm thick; capitate hyphal ends usually absent in subiculum, but present in dissepiment; tapering hymenial cystidia reaching 50  $\times$  8  $\mu\text{m}$  in size; basidia 5–7  $\mu\text{m}$  broad, usually not repetitive; ..... *X. apacheriensis* (Gilb. & Canf.) Hjortstam & Ryvar den [*Hyphodontia apacheriensis* (Gilb. & Canf.) Hjortstam & Ryvar den]; distr.: North America
- Spores up to 4(–4.5)  $\mu\text{m}$  broad; pores to 0.3 mm deep; subiculum to 0.15 mm thick; capitate hyphal ends in subiculum numerous; tapering hymenial cystidia reaching about 30  $\times$  6  $\mu\text{m}$  in size; basidia 4.5–5  $\mu\text{m}$  broad, often repetitive ..... 7
- 7 Pores rounded; spores (3–)3.3–4  $\mu\text{m}$  broad ..... *X. niemelaei* (Sheng H. Wu) Hjortstam & Ryvar den (*Hyphodontia niemelaei* Sheng H. Wu subsp. *niemelaei* Sheng H. Wu); distr.: East Asia, Africa, South America
- Pores somewhat elongated; spores 3.7–4(–4.5)  $\mu\text{m}$  broad ..... *X. gracilis* (Hjortstam & Ryvar den) Hjortstam & Ryvar den (*Hyphodontia niemelaei* subsp. *gracilis* Hjortstam & Ryvar den); distr.: South America
- 8 Spores subballantoid ..... *X. syringae* (E. Langer) Hjortstam & Ryvar den (*Hyphodontia syringae* E. Langer); distr.: East Asia
- Spores subglobose to oblong ..... 9
- 9 Pores 1–3/mm; spores subglobose to broadly ellipsoid ..... 10
- Pores 4–7/mm; spores narrowly ellipsoid to oblong, 4–5.5  $\times$  2.5–3.2  $\mu\text{m}$  ... 11
- 10 Pores about 3/mm; margin filamentous-arachnoid, without rhizomorphs; spores subglobose, 4.2–5  $\times$  4–4.3  $\mu\text{m}$ ; capitate cystidia 15–23  $\times$

- 4.5–3  $\mu\text{m}$  ..... ***X. hallenbergii*** (Sheng H. Wu) Hjortstam & Ryvar-  
den (*Hyphodontia hallenbergii* Sheng H. Wu); distr.: East Asia  
– Pores 1–2/mm; margin with white rhizomorphs; spores broadly ellipsoid/  
ellipsoid, (4–)4.3–5.5(–6)  $\times$  3.5–4(–4.3)  $\mu\text{m}$ ; capitate cystidia 20–27  $\times$   
6–7  $\mu\text{m}$  ..... ***Hypho-***  
***dontia rhizomorpha*** C.L. Zhao, B.K. Cui & Y.C. Dai; distr.: East Asia  
11 Pores 4–6/mm, up to 0.35 mm deep; capitate cystidia 10–45  $\times$  3.5–5  $\mu\text{m}$ ,  
apically capped with resinous matter; basidia 14–20  $\mu\text{m}$  long; spores 4.5–5.5  
 $\mu\text{m}$  long ..... ***X. taiwanianus*** (Sheng H. Wu) Hjort-  
stam & Ryvar- den (*Hyphodontia taiwaniana* Sheng H. Wu); distr.: East Asia  
– Pores 6–7/mm, to about 1 mm deep; capitate cystidia 11–13.5  $\times$  4–6  
 $\mu\text{m}$ , without resinous cap; basidia 9–12.5  $\mu\text{m}$  long; spores (4–)4.3–5  $\mu\text{m}$   
long ..... ***Hypho-***  
***dontia pseudotropica*** C.L. Zhao, B.K. Cui & Y.C. Dai; distr.: East Asia  
12 Spores allantoid, 1–1.5  $\mu\text{m}$  broad ..... ***X. scopinellus*** (Berk.) Hjortstam  
& Ryvar- den [*Odontia scopinella* (Berk.) Berk.]; distr.: Australia, New Zealand  
– Spores subglobose to cylindrical or suballantoid, at least 2  $\mu\text{m}$  broad ..... **13**  
13 Apically acute cystidia or acuminate hyphal ends regularly present in hyme-  
nium and/or at sterile apices of aculei ..... **14**  
– All cystidia apically blunt (but can be tapering), or acuminate elements rare  
and only at aculeal apices or occasionally in hymenium ..... **35**  
14 Acuminate hyphal ends or acuminate cystidia confined to sterile aculeal  
apices ..... **15**  
– Acuminate cystidia or cystidioles also in hymenium ..... **20**  
15 With hypha-like, thick-walled tramal cystidia, somewhat constricted and flexu-  
ous, often richly encrusted and with adventitious septa, apically blunt, subcapitate  
or acute ..... ***X. lanatus*** (Burds. & Nakasone) Hjortstam & Ryvar- den (*Hypho-*  
*dontia lanata* Burds. & Nakasone); distr.: North and South America, East Asia  
– Thick-walled tramal cystidia absent ..... **16**  
16 With hastocystidia, 40–60  $\times$  6–8  $\mu\text{m}$ , at aculeal apices .....  
..... ***X. hastifer*** (Hjortstam & Ryvar- den) Hjortstam & Ry-  
var- den (*Hyphodontia hastifera* Hjortstam & Ryvar- den); distr.: South America  
– No hastocystidia; acuminate hyphal ends in aculei 2–4  $\mu\text{m}$  broad ..... **17**  
17 With enclosed, more or less constricted (torulose) cystidia; capitate and sub-  
capitate cystidia often provided with resinous cap ..... **18**  
– Torulose cystidia absent; capitate and subcapitate cystidia naked, seldom  
with resinous cap ..... **19**  
18 Cylindrical sterile elements in hymenium (if present) up to 4  $\mu\text{m}$  broad; toru-  
lose cystidia with oily contents (like gloeocystidia), sometimes very rare; spores  
ellipsoid, 4–5  $\times$  3–3.5  $\mu\text{m}$  ..... ***X. brevisetus*** (P. Karst.) Hjortstam & Ryvar- den  
[*Hyphodontia breviseta* (P. Karst.) J. Erikss.]; distr.: temperate north hemisphere  
– Subclavate/short cylindrical cystidia common or scattered in hymenium,  
4.5–8.5  $\mu\text{m}$  broad; torulose cystidia with non-oily contents; most basidi-

- ospores broadly ellipsoid, some subglobose,  $4\text{--}5.5(-6) \times (3\text{--})3.5\text{--}4(-4.5)$   $\mu\text{m}$ .....***Hyphodontia subclavata*** Yurchenko, H.X. Xiong & Sheng H. Wu; distr.: East Asia
- 19 Spores ellipsoid to oblong, convex or flat adaxially,  $5.5\text{--}6.5(-7) \times 3.5\text{--}4.5$   $\mu\text{m}$ ; capitate cystidia present in hymenium...***X. pruni*** (Lasch) Hjortstam & Ryvar den [*Hyphodontia pruni* (Lasch) Svrček]; distr.: Eurasia, North Africa, North America
- Spores ellipsoid, flat or depressed adaxially,  $(5\text{--})6\text{--}7 \times 2.5\text{--}3.5$   $\mu\text{m}$ ; capitate cystidia absent, subcapitate elements very few.....***Hyphodontia novozelandica*** Gorjón & Gresl.; distr.: New Zealand
- 20 All hyphae covered with dark yellow or brown granular material, dissolving and turning violet in KOH.....***X. australis*** (Berk.) Hjortstam & Ryvar den [*Hyphodontia australis* (Berk.) Hjortstam]; distr.: Australia, South America
- The hyphal incrustations colorless or pale colored, not turning violet in KOH.....**21**
- 21 Hymenophore smooth to minutely odontoid, with the longest aculei reach ing  $0.05\text{--}0.3$  mm in length.....**22**
- Hymenophore odontoid to hydroid and almost irpicoid, with aculei reaching  $0.5\text{--}3$  mm long.....**31**
- 22 Spores cylindrical to subballantoid,  $(2\text{--})2.5\text{--}3(-3.5)$   $\mu\text{m}$  broad .....**23**
- Spores subglobose to oblong,  $3\text{--}4$   $\mu\text{m}$  broad.....**25**
- 23 Basidioma very thin (mostly about  $25$   $\mu\text{m}$  thick); hymenial surface smooth ...  
.....***Hyphodontia tenuissima*** Yurchenko & Sheng H. Wu; distr.: East Asia
- Basidioma usually  $50$   $\mu\text{m}$  or more thick; hymenial surface scarcely aculeate (in younger parts smooth) to densely odontoid.....**24**
- 24 Hymenial surface whitish or greyish, with sterile peg-like projections ( $11\text{--}15$  projections/mm).....***Hypho- dontia vietnamensis*** Yurchenko & Sheng H. Wu; distr.: Southeast Asia
- Hymenial surface yellowish or cream-colored, with at least partly fertile aculei (about  $5$  aculei/mm) .....***X. crustosus*** (Pers.: Fr.) Chevall [*Hyphodontia crustosa* (Pers.: Fr.) J. Erikss., *H. burtii* (Peck) Gilb.]; distr.: cosmopolitan
- The species is very variable, especially in macromorphology and spore mor- phology. Hjortstam and Ryvar den (1997) noted a specimen from Colombia under the name *Hyphodontia* cf. *crustosa*, with ellipsoid spores. A morpho- logical variant called *Hyphodontia crustosa* “*jacutica*” (Eriksson et al. 1981), or *H. jacutica* (Eriksson and Ryvar den 1976), differs from *H. crustosa* by nar- rowly ellipsoid spores, and this may represent a taxon of its own.
- 25 Spores subglobose; hymenophore smooth or scanty odontoid.....**26**
- Spores broadly ellipsoid to oblong; hymenophore smooth to densely odon- toid.....**27**
- 26 Basidia bisterigmate; spores  $5.5\text{--}7 \times 4.5\text{--}6$   $\mu\text{m}$ , thin-walled; subulate cystidia  $18\text{--}25 \times 4.5\text{--}6$   $\mu\text{m}$ ; hymenophore smooth.....***X. bisporus*** (Boidin & Gilles) Hjortstam & Ryvar den (*Hyphodontia bispora* Boidin & Gilles); distr.: Europe

- Basidia with (2)4 sterigmata; spores about  $5 \times 3.8\text{--}4\ \mu\text{m}$ , slightly thick-walled; subulate cystidia  $30\text{--}40 \times 3.5\text{--}5\ \mu\text{m}$ ; hymenophore at first smooth, later with minute, separated aculei .....  
.....***X. crustosoglobosus*** (Hallenb. & Hjortstam) Hjortstam & Ryvar den (*Hyphodontia crustosoglobosa* Hallenb. & Hjortstam); distr.: South America
- 27 Capitate (including lecythiform) elements present in hymenium ..... **28**
- Capitate cystidial elements absent, or present only in aculei or in subhyme-  
nium ..... **29**
- 28 Hymenial surface salmon-colored when dry; hymenial cystidia of three types:  
tapering,  $2\text{--}3.5\ \mu\text{m}$  wide, capitate, and lecythiform; spores ellipsoid .....  
....***Hyphodontia macrescens*** (Banker) Ginns & Lefebvre; distr.: North America  
According to Hjortstam and Ryvar den (2009), this is a name of unknown  
application.
- Hymenial surface ochraceous- or cinnamon-yellow; cystidia of two types:  
tapering,  $3\text{--}5\ \mu\text{m}$  wide, and lecythiform; spores ellipsoid to narrowly ellip-  
soid ..... ***X. rimosissimus*** (Peck) Hjortstam & Ryvar den [*Hyphodon-  
tia rimosissima* (Peck) Gilb. sensu Gilbertson (1962)]; distr.: North America
- 29 Hymenophoral aculei consisting of strongly flexuous hyphae with blunt, sub-  
capitate or capitulate apices ..... ***X. candidissimus***  
(Berk. & M.A. Curtis) Hjortstam & Ryvar den [*Hyphodontia candidis-  
sima* (Berk. & M.A. Curtis) E. Langer]; distr.: North and South America
- Hymenophoral aculei, if present, consisting apically of acute cystidial ele-  
ments ..... **30**
- 30 Hymenophore smooth to minutely tuberculate, white to yellowish; basidio-  
ma not stratified, except at the differentiation zone of subhymenium and sub-  
iculum; hymenial surface more or less matt ***X. juniperi*** (Bourdot & Galzin)  
Hjortstam & Ryvar den [*Hyphodontia juniperi* (Bourdot & Galzin) J. Erikss.  
& Hjortstam]; distr.: Eurasia, Macaronesia, North and South America
- Hymenophore distinctly warted to odontoid (basidioma can be partly  
smooth), yellowish to ochraceous; basidioma when well developed, some-  
what stratified; hymenial surface more or less glossy .....  
..... ***X. stratosus*** (Hjortstam & Ryvar den) Hjortstam & Ryvar den  
(*Hyphodontia stratosus* Hjortstam & Ryvar den); distr.: Africa, South America
- 31 Spores cylindrical to subballantoid,  $2.5\text{--}3.5\ \mu\text{m}$  broad .....  
..... ***X. quercinus*** (Pers.: Fr.) Gray [*Hy-  
phodontia quercina* (Pers.: Fr.) J. Erikss.]; distr.: temperate north hemisphere
- Spores subglobose to narrowly ellipsoid,  $(3.2\text{--})3.5\text{--}4.5\ \mu\text{m}$  broad ..... **32**
- 32 Basidioma up to 0.8 mm thick between aculei; torulose, apically rounded  
cystidia with 2–9 constrictions present ..... ***Hyphodontia  
anmashanensis*** Yurchenko, H.X. Xiong & Sheng H. Wu; distr.: East Asia
- Basidioma about 0.05 mm thick between aculei; constricted cystidia if pre-  
sent, with 1–5 constrictions and apically acute ..... **33**



- 33 Spores narrowly ellipsoid or oblong,  $5\text{--}6.3 \times 3\text{--}4 \mu\text{m}$ ; capitate hyphal ends, if present, without resinous cap; cystidia ventricose-submucronate, thin- or slightly thick-walled towards the base.....  
.....*X. submucronatus* (Hjortstam & Renvall) Hjortstam & Ryvar den (*Hyphodontia submucronata* Hjortstam & Renvall); distr.: Africa
- Spores subglobose to ellipsoid,  $4.5\text{--}5\text{--}(5.5) \times (3.5\text{--})4\text{--}4.5 \mu\text{m}$ ; capitate hyphal ends in hymenium often with resinous caps; cystidia fusoid with 1–5 constrictions, acuminate, thin-walled.....**34**
- 34 Hymenophoral aculei flattened, incised, rarely conical or subcylindrical .....  
.....*X. spathulatus* (Schrader : Fr.) Kuntze [*Hyphodontia spathulata* (Schrader : Fr.) Parmasto]; distr.: cosmopolitan
- Hymenophoral aculei triangular at base, subulate above, arranged in more or less parallel rows..... *Hyphodontia fimbriiformis* (Berk. & M.A. Curtis) Ginns & Lefebvre '*fimbriaeformis*'; distr.: North America Hjortstam and Ryvar den (2009) synonymized this name with *X. spathulatus*.
- 35 Astrocystidia present on subicular hyphae .....  
...*Hyphodontia astrocystidiata* Yurchenko & Sheng H. Wu; distr.: East Asia
- Astrocystidia lacking in subiculum.....**36**
- 36 Thick-walled, hypha-like, more or less encrusted, constricted and septate cystidia present, projecting in bundles at aculeal apices.....**37**
- All cystidia thin-walled or slightly thick-walled in lower part, aseptate.....**40**
- 37 Spores cylindrical  $2\text{--}2.5\text{--}(3) \mu\text{m}$  wide; hymenial cystidia subcapitate .....*X. nespori* (Bres.) Hjortstam & Ryvar den [*Hyphodontia nespori* (Bres.) J. Erikss. & Hjortstam, *Odontia papillosa* (Fr.) Bres. sensu Nikolajeva, 1961]; distr.: cosmopolitan Spores in *O. papillosa*, according to Nikolajeva (1961), are larger than *X. nespori* measuring  $5\text{--}8 \times 2\text{--}3.5 \mu\text{m}$ .
- Spores broadly ellipsoid to oblong  $3\text{--}4\text{--}(5) \mu\text{m}$  wide .....**38**
- 38 Capitate hyphal ends (vesicles) present in subiculum*X. lanatus* (see step 15)
- No capitate hyphal ends in subiculum .....**39**
- 39 Cystidia at aculeal apices flexuous and subcapitate; aculei fertile at base; basidia  $15\text{--}17 \mu\text{m}$  long.....*X. serpentiformis* (E. Langer) Hjortstam & Ryvar den (*Hyphodontia serpentiformis* E. Langer); distr.: East Asia, Macaronesia *Hyphodontia crassa* Sang H. Lin & Z.C. Chen was considered as synonym of *H. serpentiformis* by Dai et al. (2004).
- Cystidia straight or slightly wavy, apically hypha-like, forming sterile peg-like fascicles; basidia  $15\text{--}35 \mu\text{m}$  long .....  
.....*Hyphodontia echinata* Yurchenko & Sheng H. Wu; distr.: East Asia
- 40 Lepto- or gloecystidia present, of tramal or subhymenial origin, longer, than  $30 \mu\text{m}$ , or if shorter, then reaching  $8\text{--}15 \mu\text{m}$  in width.....**41**
- Lepto- or gloecystidia absent, or if hymenial leptocystidia present, then up to  $30 \times 8 \mu\text{m}$ , or somewhat thick-walled in lower  $1/2\text{--}2/3$  .....**48**
- 41 Hymenophore smooth to tuberculate .....**42**

- Hymenophore odontoid to hydroid.....**43**
- 42 Cystidia of three types: enclosed cylindrical gloecystidia, capitate and hyphoid cystidia; cylindrical hyphoid cystidia  $40\text{--}70(-80) \times (3\text{--})4\text{--}5(-5.5) \mu\text{m}$ .....***X. tuberculatus*** (Kotir. & Saaren.) Hjortstam & Ryvar den (*Hyphodontia tuberculata* Kotir. & Saaren.); distr.: Europe
- Cystidia of one type, cylindrical or subcylindrical,  $90\text{--}100 \times 4\text{--}6 \mu\text{m}$ ; gloecystidia absent.....***X. tenuicystidius*** (Hjortstam & Ryvar den) Hjortstam & Ryvar den (*Hyphodontia tenuicystidia* Hjortstam & Ryvar den nom. inval.); distr.: South America
- 43 Capitate cystidial elements present in hymenium or subiculum, sometimes projecting from aculeal apices .....**44**
- Capitate cystidial elements lacking.....**47**
- 44 Hyphae in aculeal trama thin- to slightly thick-walled; spores thin-walled, the biggest ones  $5\text{--}5.5 \times 3.5 \mu\text{m}$  .....**45**
- Aculeal trama with thick-walled or pseudoskeletal hyphae; spores often slightly thick-walled or distinctly thick-walled, the biggest ones  $6\text{--}7 \times 4\text{--}4.5 \mu\text{m}$ .....**46**
- 45 Lepto- or gloecystidia mostly of tramal origin, submoniliform, sometimes cylindrical,  $40\text{--}60(-125) \times 4\text{--}5(-7) \mu\text{m}$ , enclosed, sometimes difficult to find; capitate cystidia in hymenium and in aculeal apices, sometimes in subiculum, naked and apically  $3.5\text{--}5.5 \mu\text{m}$  broad, or provided with a cap of resinous matter; spores ellipsoid.....***X. brevisetus*** (see step 18)  
***Hyphodontia cf. breviseta***, briefly described and illustrated in Kotiranta and Saarenoksa (2000) also keys here. It has long (about  $100 \mu\text{m}$  and more), acute sterile aculeal apices, consisting of strictly parallel, tightly agglutinated, amyloid hyphae; gloecystidia more  $90 \mu\text{m}$  long; spores  $(4.5\text{--})5\text{--}5.5 \times 3\text{--}3.5(-4) \mu\text{m}$ . In *H. breviseta*, following to the same authors, sterile aculeal apices are shorter (near  $70 \mu\text{m}$ ), and consisting of subparallel, loosely arranged, inamyloid hyphae; gloecystidia usually  $(45\text{--})50\text{--}70 \mu\text{m}$  long; spores  $4\text{--}4.5(-6) \times (2.7\text{--})3\text{--}3.5(-5) \mu\text{m}$ . Distr.: Europe
- Leptocystidia of subhymenial origin, cylindrical, fusoid or clavate, often apically projecting,  $35\text{--}50 \times (5.5\text{--})6\text{--}8(-9) \mu\text{m}$ ; capitate cystidia only embedded in subiculum and aculeal trama, naked, apically  $5\text{--}8 \mu\text{m}$  broad; spores narrowly ellipsoid to oblong .....***Hyphodontia heterocystidiata*** H.X. Xiong, Y.C. Dai & Sheng H. Wu; distr.: East Asia  
The species is referred by Gorjón (2012) to the *H. breviseta* complex.
- 46 Capitate cystidia enclosed or projecting, mostly capped with resinous matter; leptocystidia enclosed; spores thick-walled,  $(5\text{--})5.5\text{--}6(-7) \times 4\text{--}4.5 \mu\text{m}$  .....***X. crassisporus*** (Gresl. & Rajchenb.) Hjortstam & Ryvar den (*Hyphodontia crassisporea* Gresl. & Rajchenb.); distr.: South America
- Capitate cystidia in subiculum only, without resinous cap; leptocystidia enclosed or projecting up to  $30 \mu\text{m}$ ; spores thin- to slightly thick-walled,

- 4–6 × 3–4 µm..... ***Hyphodontia sinensis*** H.X. Xiong, Y.C. Dai & Sheng H. Wu; distr.: East Asia
- 47 Hymenophore odontoid-hydroid, with aculei 0.2–0.8 mm long; leptocystidia of tramal and subhymenial origin, cylindrical to torulose, 15–70 × 5–8 µm; spores 4–5 × 3–3.5 µm..... ***X. lenis***
- Hjortstam & Ryvarden (*Hyphodontia mollis* Sheng H. Wu); distr.: East Asia
- Hymenophore odontoid, with aculei up to 0.4 mm long; leptocystidia only hymenial, subcylindrical, clavate, almost pyriform, 20–35 × 4.5–15 µm; spores 5–6 × 3.5–4.5 µm .....
- ..... ***Hyphodontia pelliculae*** (H. Furuk.) N. Maek.; distr.: East Asia
- 48 Capitate, subcapitate or capitulate cystidial elements abundant to scattered, but regularly present in hymenium or at aculeal apices ..... **49**
- Capitate and similar cystidial elements absent or occasional..... **68**
- 49 Resinous caps present on some or many capitate cystidia ..... **50**
- Capitate cystidia lacking resinous cap ..... **53**
- 50 Hymenial surface with fairly sparse aculei (1–3/mm), separated or connected by crests ..... **51**
- Hymenial surface densely tuberculate to densely odontoid (6–10 aculei/mm), without crests ..... **52**
- 51 Aculei separated; capitate cystidia 4.5–5.5(–6) µm broad, often lacking resinous cap; spores subglobose to broadly ellipsoid, 3.5–4.5(–5) µm broad ...
- ..... ***X. asperus***
- (Fr.) Hjortstam & Ryvarden [*Hyphodontia aspera* (Fr.) J. Erikss., *H. granulosa* (Pers.: Fr.) Ginns & Lefebvre nom. superfl.]; distr.: temperate Eurasia
- Aculei often connected by crests; capitate cystidia 3–4.5 µm broad, usually with a cap of resinous matter; spores ellipsoid, 3.5–4 µm broad.....
- ..... ***Hyphodontia subspathulata*** (H. Furuk.) N. Maek.; distr.: East Asia
- Hjortstam and Ryvarden (2009) consider this name as a synonym of *X. spathulatus*. However, in Maekawa's description (1993) no acuminate, constricted gloeocystidia were mentioned.
- 52 Basidioma white or cream-colored, with age pale ochraceous; aculei narrowly conical or subcylindrical; hyphal texture in subiculum and trama loose; spores (5–)5.5–6.5(–7) × 3.5–4.5(–5) µm..... ***X. pruni*** (see step 19)
- Basidioma creamish or often pale ochraceous and reddish ochraceous; aculei conical to almost semiglobose; hyphal texture in subiculum and trama fairly dense; spores 5–6 × 3.5–4 µm..... ***X. verruculosus***
- (J. Erikss. & Hjortstam) Hjortstam & Ryvarden [*Hyphodontia verruculosa* J. Erikss. & Hjortstam; *H. papillosa* (Fr.) J. Erikss. p.p., sensu Eriksson and Ryvarden (1976); *Lyomyces papillosus* (Fr.) P. Karst.]; distr.: Europe
- In many taxonomical works *Hyphodontia verruculosa* is considered to be a synonym of *H. rimosissima*. However, Hjortstam and Ryvarden (2009) treated *X. verruculosus* separately from *X. rimosissimus* (see step 28).

- 53 Spores 7.5–10  $\mu\text{m}$  long, ovoid to subballantoid; aculeal apices with subulate or hypha-like, apically capitulate cystidia .....  
 ..... ***X. adhaerisporus*** (E. Langer) Hjortstam & Ryvar den  
 (*Hyphodontia adhaerispora* E. Langer); distr.: southwest Indian Ocean islands
- Spores up to 7  $\mu\text{m}$  long, subglobose to oblong, never concave adaxially; aculeal apices with hypha-like, tapering, capitate or capitulate cystidia ..... **54**
- 54 Capitate cystidia apically 8–12  $\mu\text{m}$  broad, projecting about 20  $\mu\text{m}$  ..... ***X. capitatus*** (G. Cunn.) Hjortstam & Ryvar den [*Hyphodontia cunninghamii* Gresl. & Rajchenb., non *Hyphodontia capitata* (Boidin & Gilles) Hjortstam]; distr.: Australia, New Zealand
- Capitate or subcapitate cystidia apically up to 6(–7)  $\mu\text{m}$  broad, projecting or enclosed ..... **55**
- 55 Capitate cystidia predominating at aculeal apices, naked or slightly encrusted ..... ***Hyphodontia capitatocystidiata*** H.X. Xiong, Y.C. Dai & Sheng H. Wu; distr.: East Asia
- Aculeal apices consisting predominantly of tapering or cylindrical cystidia or hyphal ends, otherwise capitate cystidia richly encrusted (incrusted dissolving in KOH) ..... **56**
- 56 With fairly straight, hyphoid, projecting cystidia, somewhat broadened apically and thick-walled there, and somewhat broadened basally .....  
 ..... ***X. borealis*** (Kotir. & Saaren.) Hjortstam & Ryvar den (*Hyphodontia borealis* Kotir. & Saaren.); distr.: temperate Eurasia  
 This taxon was depicted under the name *Hyphodontia* aff. *nudiseta* in Langer (1994).
- Hyphoid cystidia if present, then not broadened and thick-walled apically ..... **57**
- 57 Spores (5–)5.5–6.5(–7)  $\mu\text{m}$  long ..... **58**
- Spores 3.8–5(–6)  $\mu\text{m}$  long ..... **61**
- 58 Hymenophoral aculei 10–15/mm; capitate, subcapitate and capitulate cystidia 20–60  $\times$  4–6  $\mu\text{m}$ , typically present in aculei .....  
 ..... ***X. fimbriatus*** (Sheng H. Wu) Hjortstam & Ryvar den (*Hyphodontia fimbriata* Sheng H. Wu); distr.: East Asia, South America
- Hymenophoral aculei 6–12/mm; capitate and similar cystidia 15–40  $\times$  3–5  $\mu\text{m}$ , often absent in aculei ..... **59**
- 59 Spores thin-walled, 3.5–4.5(–5)  $\mu\text{m}$  broad; projecting hyphal ends in aculei subulate, obtuse, capitulate ..... ***X. pruni*** (see step 19)
- Spores slightly thick-walled when mature, 3.5–4  $\mu\text{m}$  broad; projecting hyphal ends in aculei nearly cylindrical or tapering ..... **60**
- 60 Hymenial cystidia tibiiform to lecythiform .....  
 ... ***X. bugellensis*** (Ces.) Hjortstam & Ryvar den sensu Hjortstam and Ryvar den (2007a) [*Hyphodontia bugellensis* (Ces.) J. Erikss.]; distr.: Macaronesia, Africa  
 In earlier works (Eriksson and Ryvar den 1976; Langer 1994) this name was synonymized with *Hyphodontia pruni*.

- Hymenial cystidia cylindrical or subcapitate .....  
       .....*X. subscopinellus* (G. Cunn.) Hjortstam & Ryvar den [*Hyphodontia sub-*  
       *scopinella* (G. Cunn.) Greslebin & Rajchenb.]; distr.: Australia, New Zealand
- 61 Subulate cystidial elements regularly present at aculeal tips and/or in hyme-  
       nium.....62
- Subulate cystidia absent, rare, or little distinguishing from cylindrical hyphal  
       ends .....64
- 62 Many capitate cystidia with olive brownish contents; all hyphae thin-walled;  
       spores narrowly ellipsoid, 3–3.5(–4)  $\mu\text{m}$  broad .....  
       ..... *Hyphodontia* sp. 2 (Kotiranta and Saarenoksa 2000); distr.: Europe
- Capitate cystidia colorless; subicular hyphae with thickened to moderately  
       thick walls; spores broadly ellipsoid to ellipsoid, 3.5–4  $\mu\text{m}$  broad .....63
- 63 Cystidia subulate, rarely capitate; tramal hyphae with thickened walls; spores  
       thin- or slightly thick-walled .....  
       .....*Hyphodontia* sp. 1 (Kotiranta and Saarenoksa 2000); distr.: Europe.  
       European samples, treated under the name *X. nudisetus*, and having, besides  
       subulate cystidia, also slightly capitate ones (Langer 1994), possibly belong  
       here (Kotiranta and Saarenoksa 2000).
- Cystidia subcapitate and almost subulate; tramal hyphae thin-walled; spores  
       thin-walled .....*X. pruniaceus* (Hjortstam & Ryvar den) Hjortstam  
       & Ryvar den (*Hyphodontia pruniacea* Hjortstam & Ryvar den); distr.: Africa
- 64 With skeletal-like, strongly light-refractive hyphae in aculeal trama and partly  
       in subiculum.....*X. rudis* (Hjortstam & Ryvar den) Hjortstam &  
       Ryvar den (*Hyphodontia rudis* Hjortstam & Ryvar den); distr.: South America
- Skeletal-like hyphae absent, hyphae in aculeal trama thin- to slightly thick-  
       walled .....65
- 65 Hyphae in aculeal apices richly encrusted; spores 4–5  $\mu\text{m}$  long.....66
- Hyphae in aculeal apices scarcely to moderately encrusted; spores up to 5.5–6  
        $\mu\text{m}$  long.....67
- 66 Capitate cystidia in hymenium between aculei, 15–18  $\mu\text{m}$  long; hyphae in aculei  
       (peg-like fascicles) flexuous, 2.5–3.5  $\mu\text{m}$  wide; spores 4–5  $\times$  3–3.5  $\mu\text{m}$ .....  
       .... *Hyphodontia microfasciculata* Yurchenko & Sheng H. Wu; distr.: East Asia
- Capitate cystidia mainly in aculei, 30–60  $\mu\text{m}$  long; hyphae in aculeal apices  
       straight, 3–4  $\mu\text{m}$  wide; spores 4.3–4.5  $\times$  4–4.3  $\mu\text{m}$  .....  
       .....*X. tenellus* Hjortstam & Ryvar den; distr.: South Americ
- 67 Hymenophoral aculei more or less scattered, usually 1–3/mm; spores subglo-  
       bose to broadly ellipsoid, 5–6  $\times$  (3.5–)4–5(–5.8)  $\mu\text{m}$  ....*X. asperus* (see step 51)
- Hymenophoral aculei more crowded; spores broadly ellipsoid, (4.2–)4.5–5(–  
       5.5)  $\times$  3.5–4  $\mu\text{m}$  .....  
       ..... *Hyphodontia* sp. 3 (Kotiranta and Saarenoksa 2000); distr.: Europe
- 68 Spores 2.2–3  $\mu\text{m}$  broad.....69
- Spores  $\geq$  3  $\mu\text{m}$  broad.....70



- 69 Spores (6–)6.5–7 × 2.2–2.5 µm; cystidia or hyphal ends in aculei tapering, thin- to moderately thick-walled; hymenophore densely odontoid; subicular hyphae (2.5–)3–4 µm diam; basidia 25–30 × 4.5–5 µm ..... ***X. nesorina*** (Hallenb. & Hjortstam) Hjortstam & Ryvarden (*Hyphodontia nesorina* Hallenb. & Hjortstam); distr.: South America
- Spores 4.5–6 × 2.5–3 µm; cystidia or hyphal ends in aculei cylindrical, thin-walled; hymenophore smooth to grandinioid; subicular hyphae 2–3 µm in diam; basidia about 15 × 3.5–4 µm ..... ***Hyphodontia papillosa*** (Fr. : Fr.) J. Erikss. sensu Gilbertson (1974); distr.: North America  
The concept of this species in Gilbertson differs from the concept of *H. verruculosa* (Ginns and Lefebvre 1993; see step 52), and resembles *X. nespori* with naked cystidia (see step 37).
- 70 Cystidia or hyphal ends in aculei with crystalline incrustations ..... 71
- Cystidia or hyphal ends in aculei naked or almost naked ..... 72
- 71 Cystidia torulose; spores thick-walled when mature ..... ***X. bugellensis*** sensu Bernicchia and Gorjón (2010) [*Hyphodontia bugellensis* sensu Melo and Tellería (1997); see also step 60]; distr.: Europe, Southwest Asia
- Cystidia subulate, often with somewhat broadened base; spores thin-walled ..... ***X. knysnanus*** (Van der Byl) Hjortstam & Ryvarden [*Hyphodontia knysnana* (Van der Byl) D.A. Reid]; distr.: Africa, South America
- 72 Hymenophoral aculei 2–4/mm; cystidia 3–4 µm broad, usually flexuous; spores ellipsoid, (6–)6.5–7(–7.5) × (3–)3.5–4 µm ..... ***X. lutescens*** (Hjortstam & Ryvarden) Hjortstam & Ryvarden (*Hyphodontia lutescens* Hjortstam & Ryvarden); distr.: South America  
Langer (1994) noted that this taxon should be treated in the genus *Hyphoderma* because of *Hyphodontia*-like hyphae are absent and spores are with granular contents. However, Hjortstam and Ryvarden (2009) referred *X. lutescens* to the same morphological group as *X. asperus* and *X. brevisetus*.
- Hymenophoral aculei crowded, more than 4/mm; cystidia basally up to 7 µm broad, straight or weakly flexuous; spores subglobose to ellipsoid, 4.5–6 × 3–4.5 µm ..... ***X. nudisetus*** (Warcup & P.H.B. Talbot) Hjortstam & Ryvarden (*Hyphodontia nudiseta* Warcup & P.H.B. Talbot; see also step 63); distr.: East Asia, Australia

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## Appendix

Species and specimens from which various cystidial elements were depicted (Fig. 1; collection acronyms follow *Index Herbariorum* – <http://sweetgum.nybg.org/science/ih>): A1, *Lagarobasidium calongei* (MA-Fungi 73256, from Dueñas et al. 2009); A2, *Kneiffiella floccosa* (MSK-F 4755); B, *Hyphodontia pallidula* (MSK-F 6937); C, *Hasodontia hastata* (GB 94809, from Eriksson and Ryvarden 1976); D, *X. brevisetus* (MSK-F 5105); E, *Hyphodontia astrocystidiata* (TNM F24764); F, *H. arguta* (TNM F24822); G, *H. rickii* (CIEFAP Rick 208 47, from Gorjón 2012); H, *Xylodon lanatus*, (TNM F1225); I, *X. lenis* (TNM F21833); J, *Hyphodontia subclavata* (TNM F24744); K, *H. heterocystidiata* (TNM F, Wu 9209-33); L, *H. heterocystidiata* (TNM F, Wu 911107-38); M, *Lagarobasidium detriticum* (MSK-F 4146); N, *Hyphodontia anmashanensis* (TNM F15201); O, *Xylodon spathulatus* (MSK-F 5663); P, *X. fimbriatus* (TNM F111); Q, *X. asperus* (TNM F17159); R, *Hyphodontia subclavata* (TNM F24742); S, *Lyomyces sambuci* (MSK-F 4155); T, *Xylodon fimbriatus* (TNM F7890); U, *Hyphodontia anmashanensis* (TNM F15201); V, *Xylodon candidissimus* (TNM F9278); W, *X. juniper* (TNM F15343); X, *X. tuberculatus* (MSK-F 7352); Y, Z, *X. brevisetus* (MSK-F 5105).